

Applicants confirm election of Group II, with traverse. Applicants submit that no evidence has been presented by the Examiner in support of the position that "the product as claimed can be used in a materially different process of using that product such as making filters." Applicants are not aware of any association between wiping cloths and filters that would support the Examiner's position.

If the restriction requirement is maintained, Applicants will cancel the non-elected claims. Further, Applicants request that the cancellation of non-elected claims be handled by a telephone conference.

Rejection under 35 USC § 112, Second Paragraph

Claims 19-21, 23 and 25 were rejected under 35 USC § 112, second paragraph as being indefinite. In particular, the Examiner noted that the specific section of the Institute of Environmental Sciences & Technology (IEST) test referenced in the claim has not been included.

Claims 19-21 and 23 have been amended to include the IEST section that corresponds to the test described in the claim. Support for the amendments may be found at page 8, line 16 to page 10, line 12 of the Specification. Applicants note that in Claim 25, the section of the IEST test for absorbance was already included in the claim.

Rejections under 35 USC § 103(a)

Claims 17-25 were rejected as being unpatentable over Daiber et al., U.S. 5,229,181. The Examiner finds that Daiber et al. disclose a knitted cleanroom wiper, which is constructed of continuous filament, polyester yarn. The fabric is heated to 460°F. The fabric of Daiber et al. differs from the claimed fabric in that the claimed fabric is heat set at 180° to 300°F. The Examiner shifts

the burden to Applicants to prove that the different processing conditions result in a different product. Further, the Examiner suggests that it would be obvious to heat set the fabric at a lower temperature, because the skilled person would be motivated to use less energy, and discovering the optimum range of heat setting involves routine skill in the art.

For the following reason, Applicants respectfully disagrees with the Examiner's finding of unpatentability.

Summary of the Invention

The object of the present invention is to provide a method of manufacturing a wiping cloth, having utility in clean rooms and other environments, where it is necessary to avoid the introduction of particulate contaminants. For example, particles in the size range of 0.5 to 20 microns are not visible to the naked eye, yet can cause defects in electronic devices. The prior art approach to minimizing particle contaminants has focused on (a) protecting the fabric from outside contamination during processing; and (b) preventing the generation of particles when the fabric is cut into the shape of wiping cloths. (Specification pg. 2, lines 4-14).

Applicants discovered that a source of particle contamination is the step of heat setting the polyester fiber; that is, low molecular weight "trimers" found in the fibers will migrate to the surface of the fiber when the fibers are heated. At the surface, the trimers crystallize or coalesce into small particles. Thus, the small particles actually generated by the fiber itself were found to be a significant source of particulate contamination (Specification pg. 4, lines 1-9).

Typically, fabric used to make wipers is washed or scoured, then dried in a tenter frame oven at temperature of between 325° and 450°F, to remove moisture and heat set the fabric.

(Specification pg. 1, lines 7-10 and *Particle 1: Reducing Contamination in Cleanroom Wipes*, Morin, Brian (March 23, 1998) Milliken & Company Technical Report). A copy of *Particle 1: Reducing Contamination in Cleanroom Wipes* is submitted herein.

Applicants have developed a process to heat set the fabric at a temperature of from 180° to 300°F, wherein the fiber or yarn used to construct the fabric has not been heated above a temperature of 300°F. (Specification pg. 3, lines 14-19.) Applicants have demonstrated a direct correlation between the temperature to which the fiber has been heated, and the particles generated by the fiber. (Specification pg. 10-11, Example 1.)

Scope and Content of the Prior Art

Daiber et al. teach that sealing the edge of a cleanroom wiper by melt fusing reduces particulate contamination. A sealed region, approximately 0.5 inch in width, is formed by heating the region to 460°F to 5 seconds, which is approximately the softening/melting temperature of PET and nylon 6, 6.. (Daiber et al. '181 col. 4, lines 47-50).

Persons skilled in the art of textile processing typically heat set polyester at a temperature of 325° to 450°F, to (a) increase fabric throughout; and (b) improve the dimensional stability of the fabric. For example, if a fabric is heat set at 375°F, it will retain its dimensional stability until such time as it is heated to a temperature higher than 375°F. (Specification pg. 1, lines 8-10.)

Differences Between the Prior Art and Claimed Invention

The present invention is directed to a wiper which is heat set. The step of heat setting is conducted at a temperature below that which is practiced in the prior art for heat setting wipers,

in order to minimize the particulate contaminants which blossom to the surface of the fiber at higher temperatures. (Specification pg. 4, lines 1-9.)

Applicants' claimed heat setting range (180° - 300°F) is well below the melting temperature of polyester. Heat setting a fabric does not entail melting or fusing the fibers which comprise the fabric, as taught Daiber et al.

The differences between prior fabrics, heat set at temperatures above 300°F, and the present invention, heat set at a temperature of 180° to 300°F, is dramatically demonstrated in the photomicrographs provided as exhibits to *Particle 1: Reducing Contamination in Cleanroom Wipes*, Figures 2 and 3. These photomicrographs were taken of continuous filament polyester fiber which was formed into a fabric and heat set at a range of temperatures. The experiment is detailed in Example 1 of the Specification. As the temperature experienced by the fiber increases, the size and number of particulates on the surface likewise increases. The formation of particulates is directly related to the concentration of contaminants, as demonstrated in Table 1 and Figure 1 of the specification.

Obviousness

The Examiner has failed to demonstrate why Daiber et al., which teach melt fusing edges, would be modified by the skilled person to achieve a method of heat-setting the fabric at well below the melt/fusing temperature of the fabric. Clearly, the utility of Daiber et al. would be lost, if the temperature was lowered into Applicants' claimed range; the edges of the fabric would not be fused and the frayed edges would generate particulates.

The Examiner's statement regarding heat setting within Applicants' claimed range being obvious to reduce energy costs is not supported by the facts of record. Attention is directed to

Particle 1: Reducing Contamination in Cleanroom Wipes, Table 1. Commercial heat setting processes of polyester wipers are conducted at temperatures above 300°F. The skilled person has already optimized heat setting fabric for wipers in numerous commercial manufacturing operations, and the conditions are well outside of Applicants claimed range!

While optimization of a range generally will not support patentability, a particular parameter must first be recognized as a result-effective variable, before the determination of optimum ranges can be characterized as “routine experimentation”. In re Antonie, 599 F2d.618, 195 USPQ 6 (CCPA 1977), MPEP § 2144.05. In the present case, there was no recognition in the prior art that the heat set temperature of the fabric had an effect on the particulates released from a wiper made out of the fabric. Applicants have amply demonstrated the criticality of the claimed temperature range employed during heat setting.

Assuming, *arguendo*, that the Examiner has established a *prima facie* case of obviousness, Applicants submit that the unexpected benefits of the claimed method rebut the *prima facie* case. (In re Chupp, 2 USPQ 1437 (CAFC 1987)).

While the references support a long felt need in the art to reduce particulate contamination caused by wipers, there is no recognition that particulate matter generated during the heat setting step had a detrimental effect on particulate count, and that the detrimental effect could be minimized or avoided altogether by lowering the temperature at which the fabric is heat set. The benefit achieved by heat setting the fabric within the claimed range is a truly unexpected and elegant solution.

In summary, Applicants have demonstrated that the claimed product, i.e. a wiper heat set at a temperature of from 180° to 300°F, is in fact physically different from a wiper heat set at a

temperature above 300°F. The physical difference is the formation of particulates on the surface of the fibers that comprise the wiper. The wiper that is heat set at the claimed (lower) temperature range has significantly less particulates on the fiber surface. Additionally, Applicants have dispelled the suggestion that the heat set temperature is merely a variable to be optimized by the skilled person to, for example, save energy, since (1) despite numerous competing commercial products on the market, none are heat set within the claimed range, and (2) there was no recognition in the art that the heat set temperature affected surface particulate formation. Finally, the evidence of unexpected benefits and solution of a long felt need in the industry, rebut a finding of obviousness.

Respectfully requested,

December 4, 2002



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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to The Commissioner of Patents and Trademarks, Washington, DC 20231, on December 4, 2002, along with an Extension of Time, and a postcard receipt.



Timothy J. Monahan
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Appendix A

Marked-Up Copy of the Claims

19. (amended) The article of Claim 18 wherein the wiper is saturated with a solvent and wherein the wiper has a particle count of particles greater than 0.5 microns of 75 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

20. (amended) The article of Claim 18 wherein the wiper is dry and wherein the wiper has a particle count of particles greater than 0.5 microns of 30 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

21. (amended) The article of Claim 17 wherein the fabric wiper has an unlaundered particle count of particles greater than 5 microns of less than 25 million/m², as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

23. (amended) The article of Claim 17 wherein the wiper has a particle count of particles greater than 0.5 microns of 30 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

26. (new) An article comprising a fabric wiper, woven or knitted from continuous filament, polyester fiber, wherein the fabric has been heat set at a temperature of from 180° to 300° F, and the polyester fiber has not been heated above a temperature of 300° F, and wherein the wiper has a fabric weight of from 1 to 9 ounces per square yard.

27. (new) The article of Claim 26 wherein the wiper has a size ranging from 6 inches by 6 inches to 12 inches by 12 inches.

28. (new) The article of Claim 26 further comprising a sealed package containing

the wiper.

29. (new) The article of Claim 28 wherein the wiper is presaturated with a solvent, and the wiper has a particle count of particles greater than 0.5 microns of 75 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

30. (new) The article of Claim 28 wherein the wiper is dry, and the wiper has a particle count of particles greater than 0.5 microns of 30 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

31. (new) The article of Claim 26 wherein the fabric is heat set at a temperature of from 200° to 275° F, and the fiber has not been heated above a temperature of 275° F.

32. (new) The article of Claim 26 wherein the fabric is heat set at a temperature of from 225° to 265° F, and the fiber has not been heated above a temperature of 265° F.

33. (new) The article of Claim 26 wherein the wiper has a linear shrinkage of less than 5% when exposed to heat of 175° F for 5 minutes.

34. (new) The article of Claim 26 wherein the wiper has an absorbance capacity of 3.75 milliliters per square meter or greater, according to IEST-RP-CC004.2 § 7.1.

35. (new) An article comprising a woven or knitted fabric wiper, constructed of textured polyester yarn, wherein the fabric has been heat set while held flat, at a temperature of from 180° to 300° F, and wherein the yarn has not been heated above a temperature of 300°, and the wiper a particle count of particles greater than 0.5 microns of 30 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

36. (new) The article of Claim 35 wherein the fabric is heat set at a temperature of from 200° to 275° F, and the fiber has not been heated above a temperature of 275° F, and

wherein the wiper has a linear shrinkage of less than 5% when exposed to heat of 175° F for 5 minutes.

Appendix B

Clean Copy of the Claims

19. (amended) The article of Claim 18 wherein the wiper is saturated with a solvent and wherein the wiper has a particle count of particles greater than 0.5 microns of 75 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

B1
20. (amended) The article of Claim 18 wherein the wiper is dry and wherein the wiper has a particle count of particles greater than 0.5 microns of 30 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

21. (amended) The article of Claim 17 wherein the fabric wiper has an unlaundered particle count of particles greater than 5 microns of less than 25 million/m², as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

B2
23. (amended) The article of Claim 17 wherein the wiper has a particle count of particles greater than 0.5 microns of 30 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

B3
26. (new) An article comprising a fabric wiper, woven or knitted from continuous filament, polyester fiber, wherein the fabric has been heat set at a temperature of from 180° to 300° F, and the polyester fiber has not been heated above a temperature of 300° F, and wherein the wiper has a fabric weight of from 1 to 9 ounces per square yard.

27. (new) The article of Claim 26 wherein the wiper has a size ranging from 6 inches by 6 inches to 12 inches by 12 inches.

28. (new) The article of Claim 26 further comprising a sealed package containing

the wiper.

29. (new) The article of Claim 28 wherein the wiper is presaturated with a solvent, and the wiper has a particle count of particles greater than 0.5 microns of 75 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

30. (new) The article of Claim 28 wherein the wiper is dry, and the wiper has a particle count of particles greater than 0.5 microns of 30 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

31. (new) The article of Claim 26 wherein the fabric is heat set at a temperature of from 200° to 275° F, and the fiber has not been heated above a temperature of 275° F.

B3
C1W1t
32. (new) The article of Claim 26 wherein the fabric is heat set at a temperature of from 225° to 265° F, and the fiber has not been heated above a temperature of 265° F.

33. (new) The article of Claim 26 wherein the wiper has a linear shrinkage of less than 5% when exposed to heat of 175° F for 5 minutes.

34. (new) The article of Claim 26 wherein the wiper has an absorbance capacity of 3.75 milliliters per square meter or greater, according to IEST-RP-CC004.2 § 7.1.

35. (new) An article comprising a woven or knitted fabric wiper, constructed of textured polyester yarn, wherein the fabric has been heat set while held flat, at a temperature of from 180° to 300° F, and wherein the yarn has not been heated above a temperature of 300°, and the wiper a particle count of particles greater than 0.5 microns of 30 million particles per square meter or less as measured by Biaxial Shake Test IEST-RP-CC004.2 § 5.2.

36. (new) The article of Claim 35 whercin the fabric is heat set at a temperature of from 200° to 275° F, and the fiber has not been heated above a temperature of 275° F, and

*b3
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wherein the wiper has a linear shrinkage of less than 5% when exposed to heat of 175° F for 5 minutes.

Particle 1: Reducing Contamination in Cleanroom Wipes

Technical Report by Brian Morin

March 23, 1998

- I. **Introduction:** This report summarizes a project to reduce the contamination present in cleanroom wipers by finding the sources in the production processes and reducing them.

A. **Use:** These wipers are primarily used in cleanrooms where semiconductors are manufactured. They are used to wipe surfaces, clean equipment, and clean up spills. In cleanroom environments, contamination can be very critical. One single particle, less than 1 μm in diameter, can cause an integrated circuit (IC) chip to be defective, costing from \$0.50 to upwards of \$50 for complex chips. In the most advanced semiconductor IC fabs, product yields of 60-70% are considered very good, with most off-quality caused by contamination. They reduce off-quality cost by preventing contamination from entering their facilities.

The wipers are used to clean all surfaces, generally at least once a day. Cleaning of process equipment is critical and one of the dirtiest tasks that occurs in the cleanrooms. Cleaning solutions are used, including surfactant solutions, isopropyl alcohol and water mixtures, and other mixtures of solvents. The wipers should not be a major source of contamination in these solutions, whether from soluble material (oils, etc.) or particulate matter. Ionic contamination is of concern because they may dope silicon, changing it from insulating to conductive and ruining the circuit.

Another use for the wipers is to wipe automobiles between coats in OEM automotive paint rooms. Several automotive manufacturers have been able to considerably reduce their bad paint warranty work by reducing contamination in their paint rooms. They have changed their wiping materials from primarily nonwoven to filament knit wipers. These wipers are unlaundered, placing strict requirements on quality control in manufacturing. Automotive manufacturers are concerned with particulate contamination as well as contamination soluble in their cleaning solvents.

Wipers sold into both of these environments can be dry, or in packages presaturated with cleaning solutions. Presaturated wipers show considerably more contamination because in storage the cleaning solution loosens contamination, enabling it to come off the wipers more readily in testing.

- B. **Manufacture:** At the present moment, the wipers are made of either 70/34 or 70/100 Dacron polyester filament yarn, which is false twist texturized, and circular knit. In the finishing process, the fabric is scoured and treated with chemical finish to improve wettability and washability. The fabric is then dried and heat-set in a tenter frame. The fabric is then cut into wipers. These wipers can be packaged as is, or sent to a cleanroom laundry to be washed and dried in an industrial cleanroom washer and dryer. From there the wipers may be either packaged dry, or presaturated in a cleaning solution.
- C. **Testing:** The fabric undergoes extensive testing and quality assurance. Milliken wipers are tested for particulate contamination with the biaxial shake test (Biaxial Shake Test, Institute of Environmental Sciences IES-RP-CC-004.2 SEC 5.2), in which the wipers are shaken using a biaxial shaker in a known quantity of filtered DI water for 5 minutes. The number of particles in the water larger than 0.5 μm and

larger than 5.0 μm in diameter is tested both before and after shaking. The difference in particles is normalized to a square meter of fabric.

Ionic contamination is tested by measuring the ion levels in the water before and after a 24-hour soak with no agitation (Short Term Extraction IES-RP-CC-004.2 SEC 6.1.2). Ions of interest include Na, Si, Li, NH₄, K, Mg, Ca, Al, Fe, Zn, Fl, Cl, NO₄, PO₄, and SO₄. Ions are tested down to a ppb level, and different specifications are set for each ion, generally below 1 ppm.

Soluble contamination, or non-volatile residues, are measured by soaking and agitating the wipers on a planar shaker in a solvent for 10 minutes, and then measuring the residues in the solvent (Short Term Extraction, IES-RP-CC-004.2 Sec 6.1.2). Solvents are DI water, isopropyl alcohol, and acetone. Primary contaminants found in this test include spinning oils and surfactants. Normal NVR levels are ~0.004 DI water, 0.03 IPA, and 0.1 acetone.

The wipers are also tested for absorbency rate and capacity (Rate and Capacity, IES-RP-CC-004.2 SEC 7.1 & 7.2). Normal absorbency rates are immediate, or 0.2 seconds. Capacity depends strongly on the fabric construction, but normalized by the weight of the fabric ranges from 2.8 to 3.3 ml/g.

- II. Contamination Identification:** A particle count of 10 million particles/m² corresponds to 1.4×10^{-5} g/m² of particles (if the average size is 1 μm). With a fabric weight of 100 g/m², this amounts to 0.000014% (or 0.14 ppm) mobile particulate contamination. Still, semiconductor manufacturers see these millions of mobile particles as contamination that reduces their yields and costs them money.

Attempts were made to isolate these particles by filtration and identify them using the x-ray fluorescence in the SEM. While some larger (several micron) particles were found, no trends were found that would identify their source or elimination. Most of the particles found through this study were identified as having heavy elements in them: Si, Al, Fe, etc.

A. SEMs of Processes: SEMs were taken of the yarn after each processing step in the manufacture of the wipers. These are shown in Figure 1. The yarn arrives from the supplier with very few particles visible on the surface, Figure 1a. After false twist texturizing, the surface is visibly deformed, showing ridges and flat areas, but still shows very little particle contamination, Figure 1b. SEMs show knit fabric is similar to the yarn just after texturizing, showing very few particles, Figure 1c.

There is a large jump in the visible surface contamination in the next processing step, Figure 1d, which involves applying the chemical finish and heat setting the fabric. SEM x-ray fluorescence was able to identify that the particles do not contain significant amounts of heavy elements. As can be expected, the number of visible surface particles is reduced in the laundering step, Figure 1e.

It is interesting to estimate the number of particles visible on the surface, and compare that estimate with the particle counts obtained by the Biaxial Shake Test. In one picture, roughly 100 particles are visible in an area that is 30 $\mu\text{m} \times 45 \mu\text{m}$, which normalizes to 7 billion particles/m², or ~1000 times as many as are measured in the Biaxial Shake Test. This number could be considerably higher, as we have not taken into account the thickness of the fabric. Thus we have a reasonable explanation of why a Biaxial Shake Test will give roughly the same results for a single wiper that is tested multiple times. It is measuring the number of mobile particles, not the number of particles present on the wiper. While the two numbers are correlated, they are do

not tell us the same thing. Only roughly 1 in 1000 particles present is mobilized in the Biaxial Shake Test. A wiper that has been soaking in a cleaning solution or solvent for more than 24 hours will show 5 - 10 times more particles mobilized in the Biaxial Shake Test, though the number of particles shown on the surface of the wiper by SEM has not changed.

- B. **Particulate Dissolution SEMs:** Wipers were heated for 16 hrs. at 350 F. SEMs of these wipers, Figure 2a, show large hexagonal particles. These wipers were then soxhlet extracted in methylene chloride for 6 hours, and investigated again under SEM. These micrographs, Figure 2b, show that the particles have been removed. Methylene chloride was chosen because polyester trimer is soluble in it, while polyester polymer is not.
- C. **Tenter frame temperature SEMs:** Cleanroom wiper fabric was dried in a tenter frame oven, at temperatures ranging from 250° F to 400° F. The identity of the polyester fabric and the drying conditions were substantially as described in Example 1 of US Patent Application No. 08/976225, filed November 21, 1997. SEMs were taken of the fabric at each temperature are shown in Figure 3a-3g. Trimer particles on the surface are larger and more numerous when the tenter frame is at higher temperature. The wipers were tested using the Biaxial Shake Test and the results are shown in Figure 4, of this report. The creation of trimer particles on the surface is a thermodynamic process that occurs much more quickly at higher temperatures.

III. **Competitive Products:** To compare to competitive fabrics, we measured the heat history of various and competitive fabrics using Differential Scanning Calorimetry. Heat history tells us the maximum temperature the fabric was exposed to in it's processing. Heat history of competitive fabrics is shown in Table 1. No filament polyester competitive fabrics were processed at temperatures below 300 F, with most of them processed above 350 F.

IV. **Conclusion:** These tests establish that polyester trimer blooms to the surface under exposure of the fiber to heat, and that this trimer forms particles, which are visible under SEM and mobilized in the Biaxial Shake Test. Lowering the temperature in the tenter frame to 250° F appeared to provide the most benefit in reducing trimer. Particles are reduced by from 50% to 85%, depending on the test and the other processing of the wipers. Wipers dried at lower temperatures were found to have a higher liquid absorption capacity, normally near 4.0 ml/g. The wipers are thicker, and the absorption capacity is proportional to the thickness, Figure 5.

I submit this Technical Report in support of prosecution of my invention entitled "Method of Manufacturing Low Contaminant Wiper", U.S. Patent Application Serial No. 09/676,161, filed September 29, 2000.

Brian G. Morin

Brian G. Morin

On this 4th day of December, 2002, before me, a Notary Public in and for the State and County aforesaid, personally appeared Brian G. Morin to me known and known to me to be the person of that name, who signed the foregoing instrument and he acknowledged the same to be his free act and deed.

Melanie Lucas

SEAL

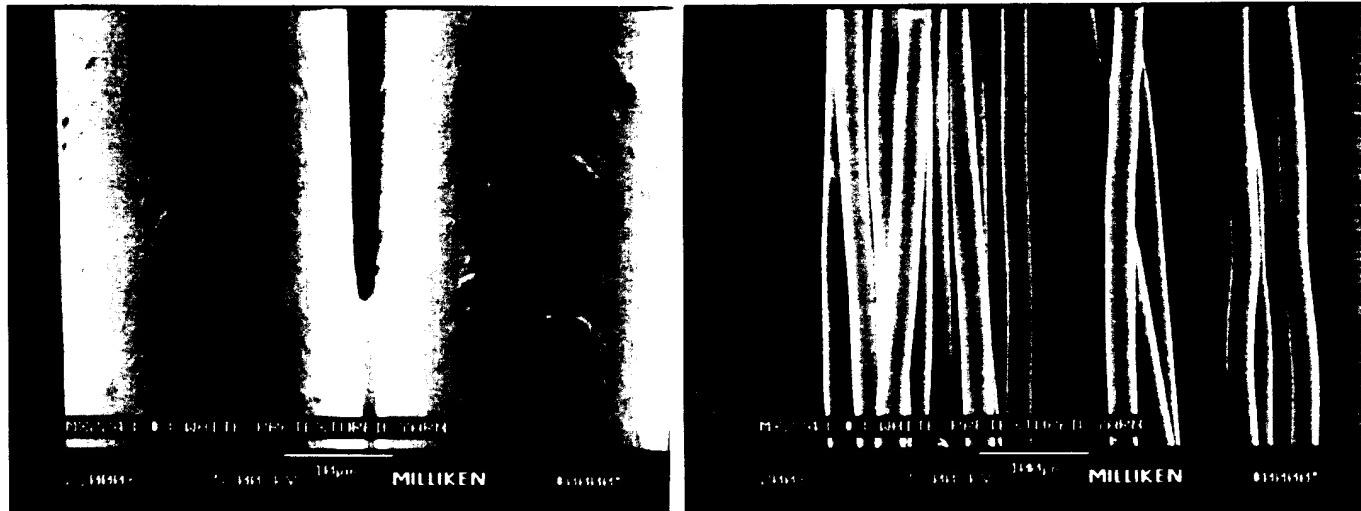
Notary Public

MY COMMISSION EXPIRES
OCTOBER 10, 2010

TABLE 1. RESULTS OF HEAT HISTORY TESTING. The temperature listed is the highest temperature that the fabric was exposed to in processing.

Sample:	Heat History (deg. F)
Texwipe	
Alpha 10	356
Alpha Lite	367
Alpha Wipe	338
Textube	338
Honeycomb	360
Texwipe 1016	376
AlphaSorb 10	340
Texwipe Black	354
Berkshire	
Ultraseal 3000	324
SuperPolx 1200	356
Polx 1200	354
Microseal 1200	343
Nega-Stat	354
Contec	
Polyknit	360
Genesis	360
Contec Blue	372
Lyman	
Purity Wipe, std. Wt.	334
Purity Wipe, hvy. Wt.	333
Lym-tech 7225-99 hvy	376
7225-99, std. Wt.,	358
7224-99, hvy. Wt.,unl	374
Super Hunt	338
7219-99, unlaundered	356
Willshire	
S/spec 4 wipe	309
Polywipe	334
Japanese	
MiniMax	379
Anticon Gold	
Black, hvy. Wt.	327
18"x18", hvy. Wt.	340
18"x18", std. Wt.	349
GoldSorb, bulk pack	342

Figure 1. SEMs of cleanroom wiper fibers after each process in the manufacture of the wipers. a. Dacron 70/34 yarn as received from DuPont.



b. Yarn after false twist texturing.



Figure 1. c. SEMs of knit fabric.



d. SEMs of finished fabric.



Figure 1. e. SEMs of finished fabric after laundering in cleanroom laundry. This is the fabric as it is packaged to be sold.

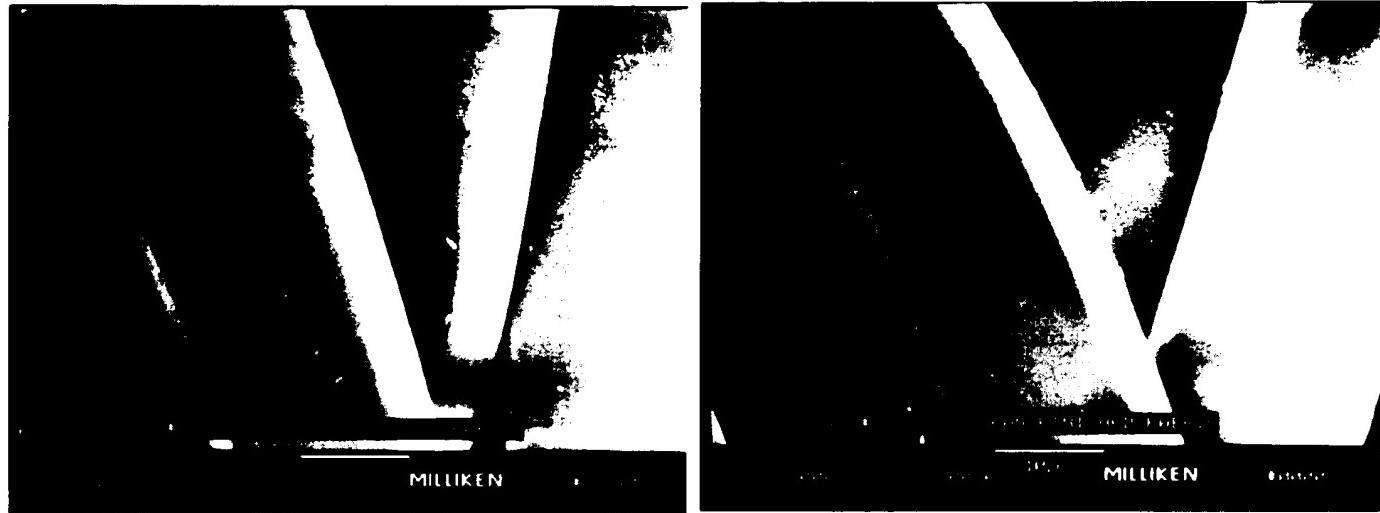


Figure 2. a. SEMs of wipers that were heated for 16 hours at 350 F, showing large hexagonal trimer crystals on the surface.

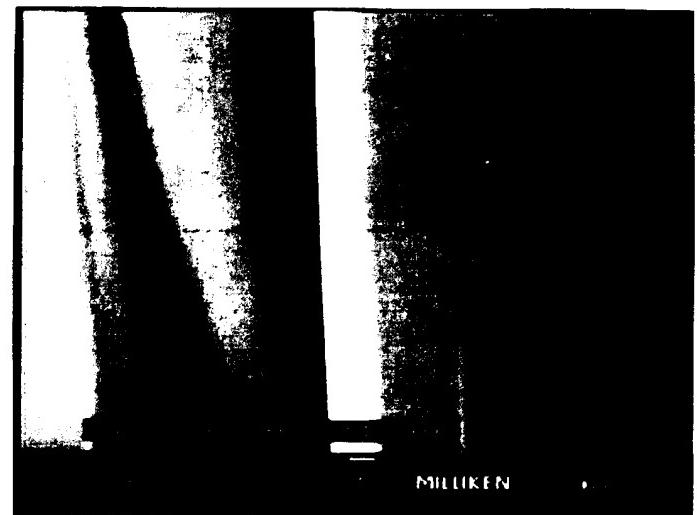


b. SEMs of the same wipers after being soxhlet extracted in methylene chloride. Trimer, which is soluble in methylene chloride, is removed.



Figure 3. SEMs of wipers run down tenter frame at various temperatures, from 250 F to 400 F, every 25 degrees.

a. 250 degrees F.



b. 275 degrees F.



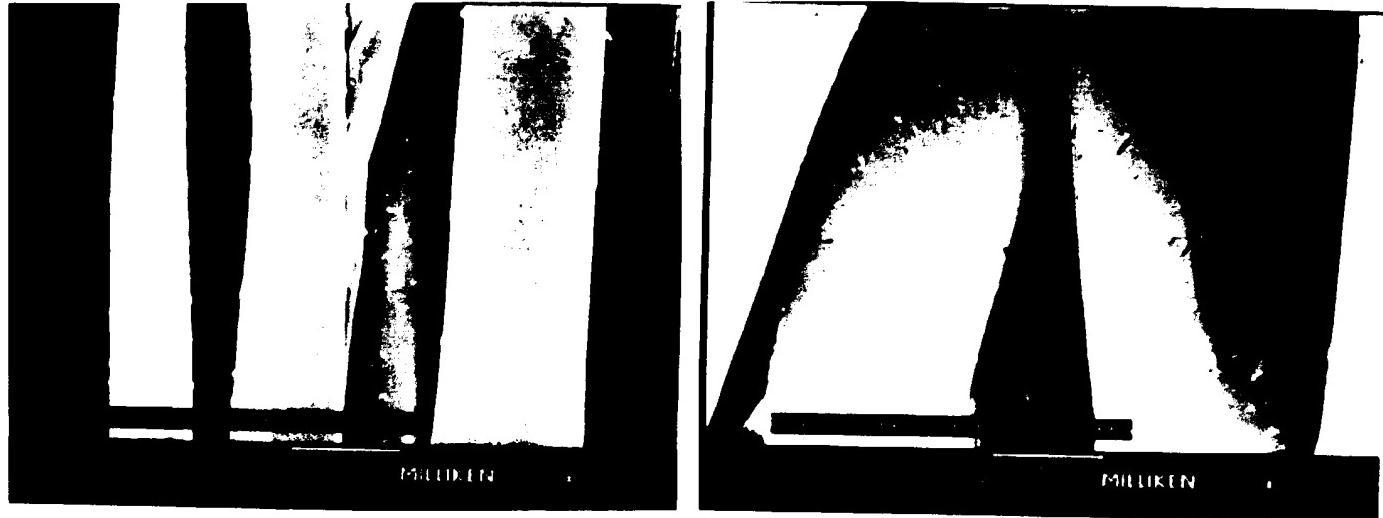
Figure 3. c. 300 degrees F



d. 325 degrees F



Figure 3. e. 350 degrees F.



f. 375 degrees F.

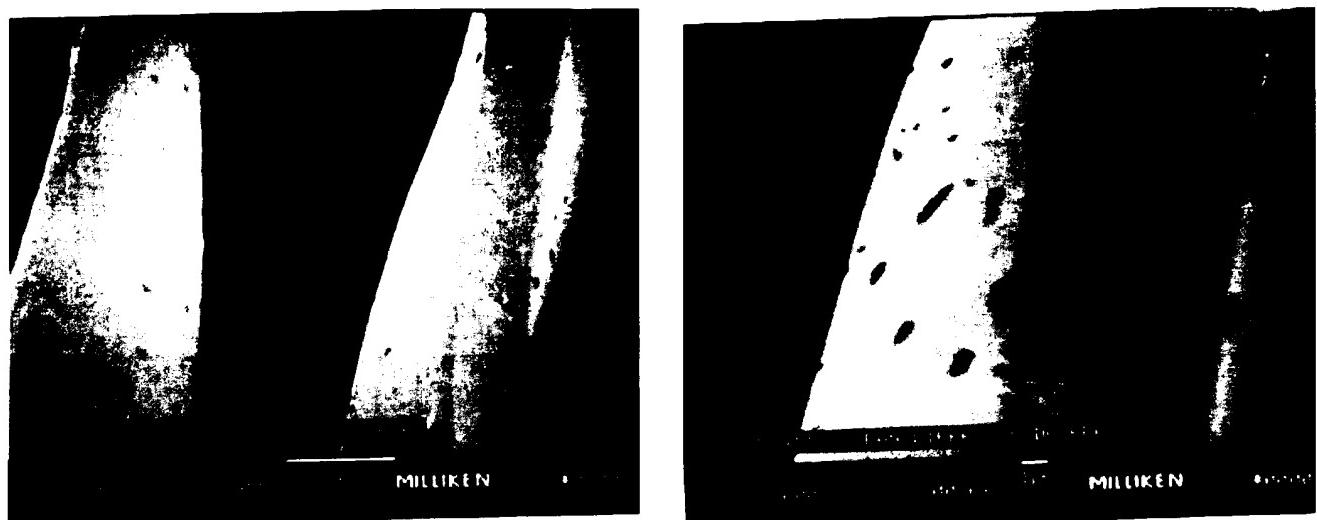
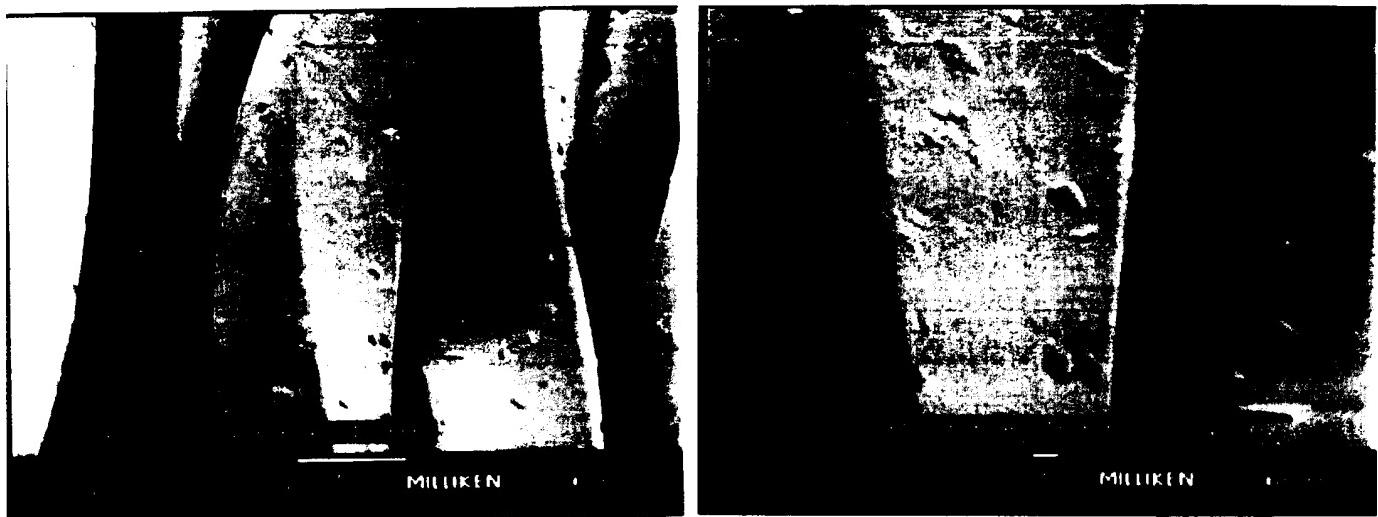


Figure 3. g. 400 degrees F.



Unwashed Tenter Temp Test

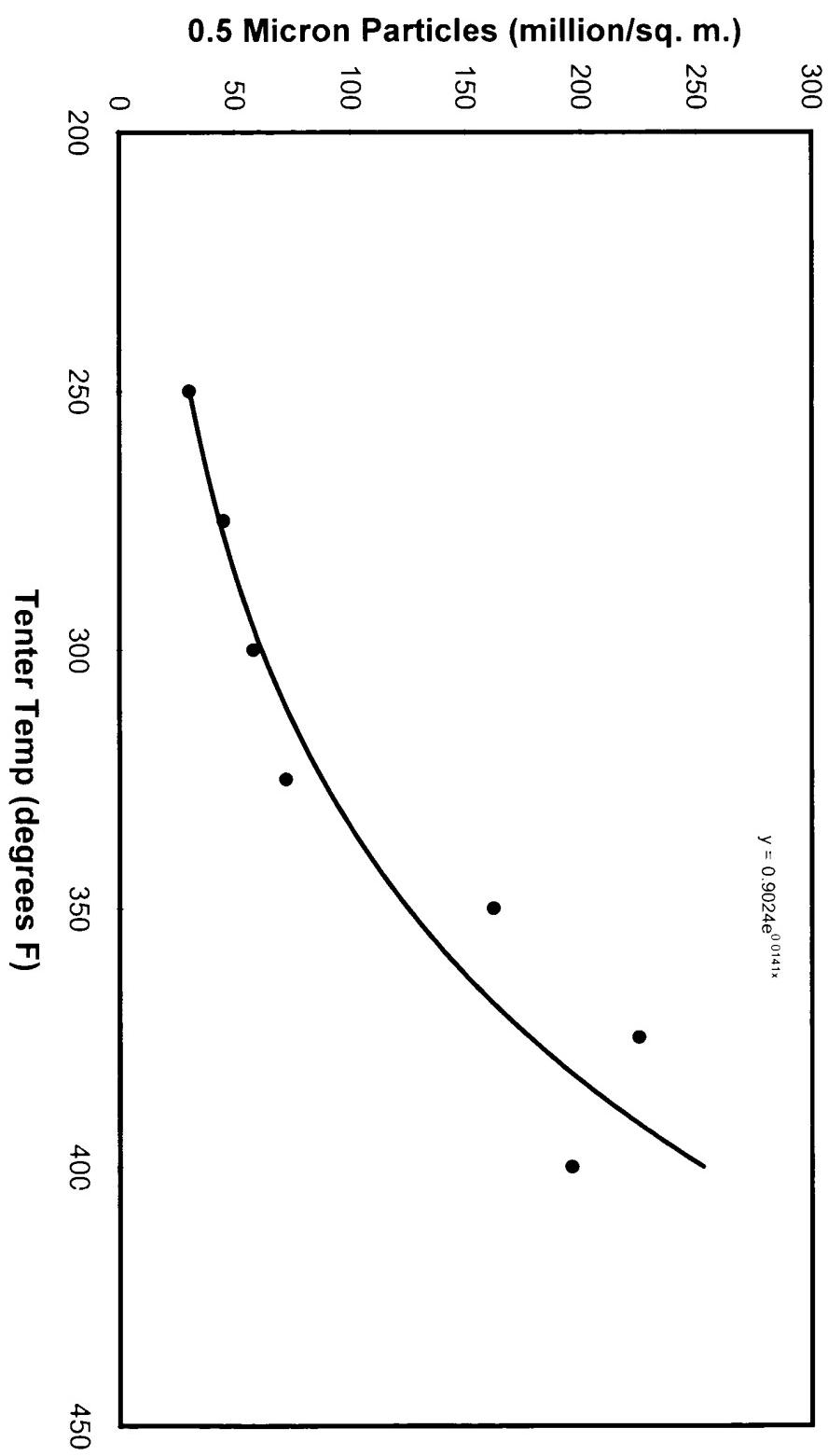


Figure 4. Biaxial Shake particle counts as a function of tenter frame temperature.

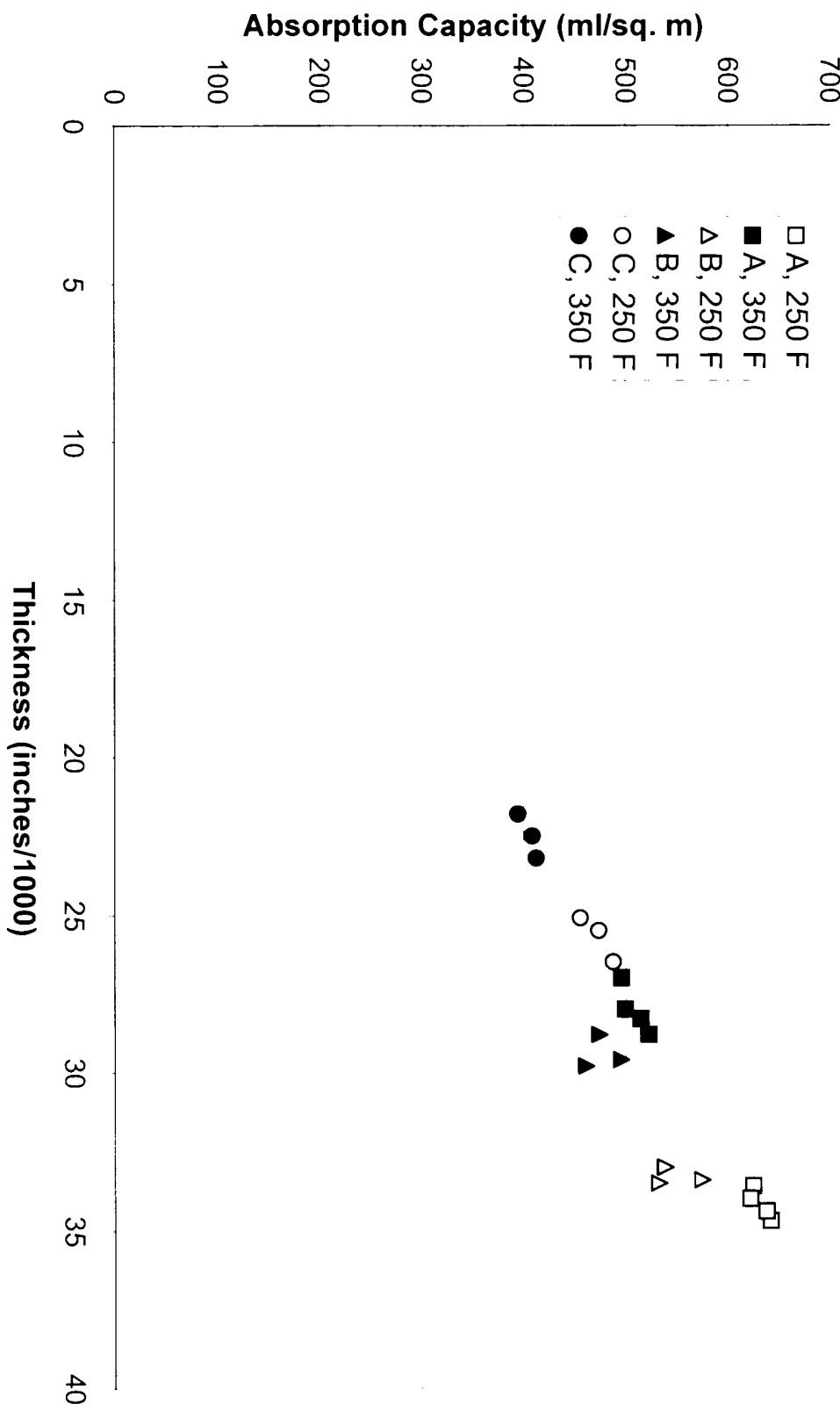


Figure 5. Absorption capacity vs. fabric thickness. A, B, C represent different fabric styles.